

Salinity Intrusion: Integrating Riverine and Coastal Forces

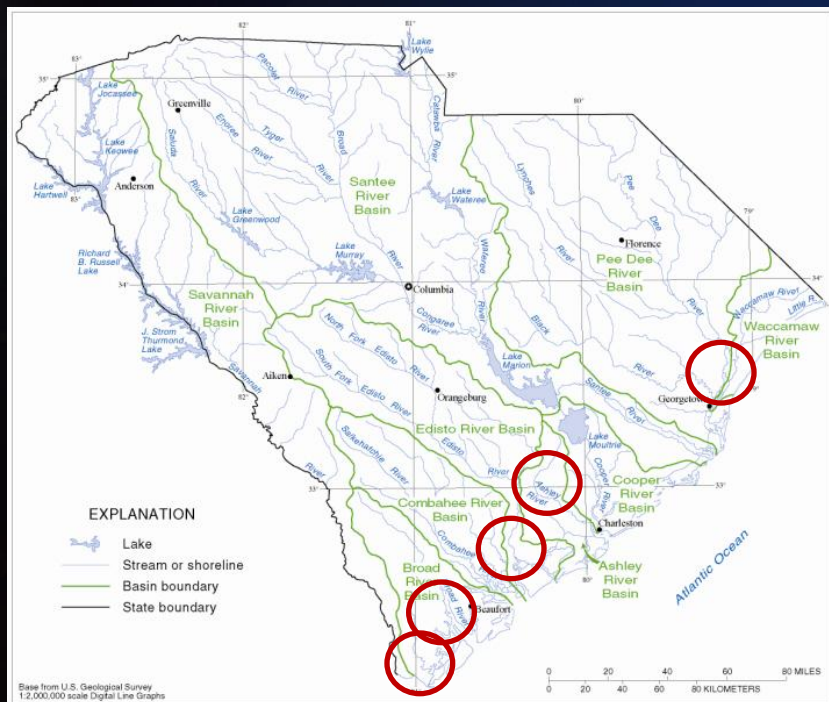
Paul Conrads

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The Climate Connection Workshop Series:
Climate Variability and Impacts to South Carolina's Natural Resources
September 13, 2012

Presentation Outline

- Conceptual model of salinity intrusion
- Look at data from 5 systems
 - Summary/Conclusions



Waccamaw River

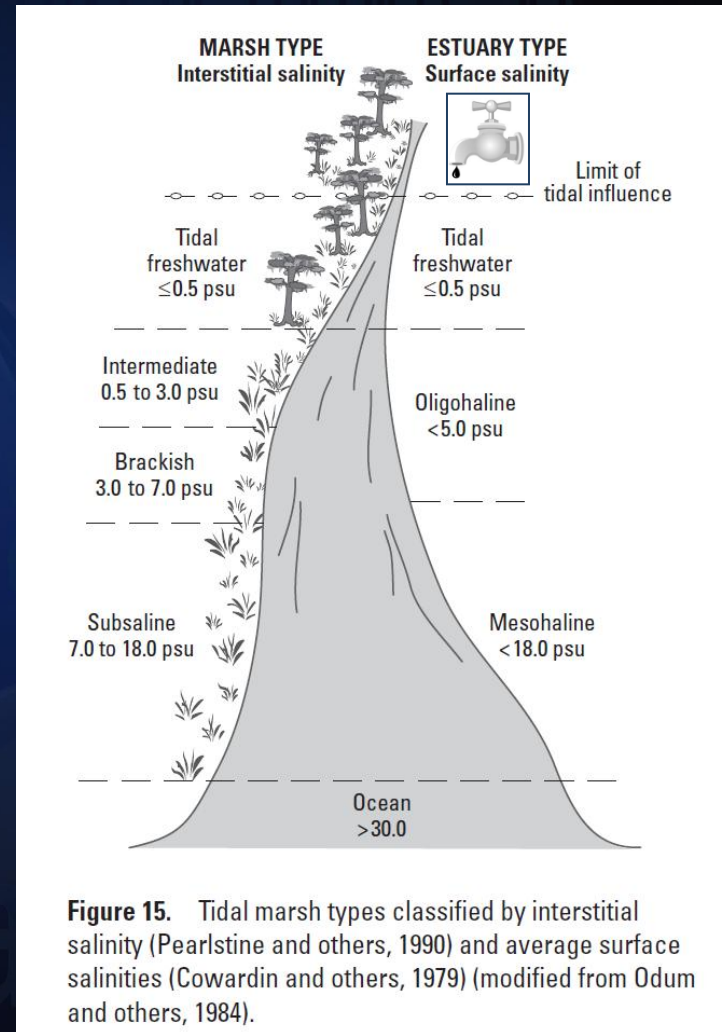
Ashley River

Beaufort River

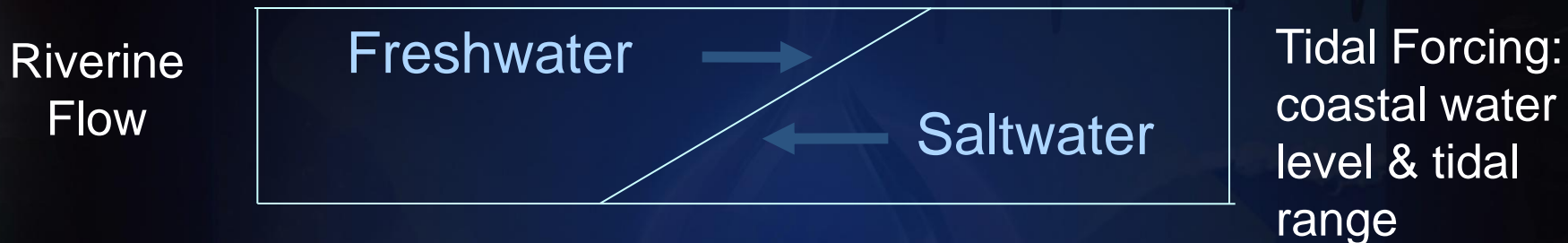
May River

Savannah River

Tidal Marsh Types



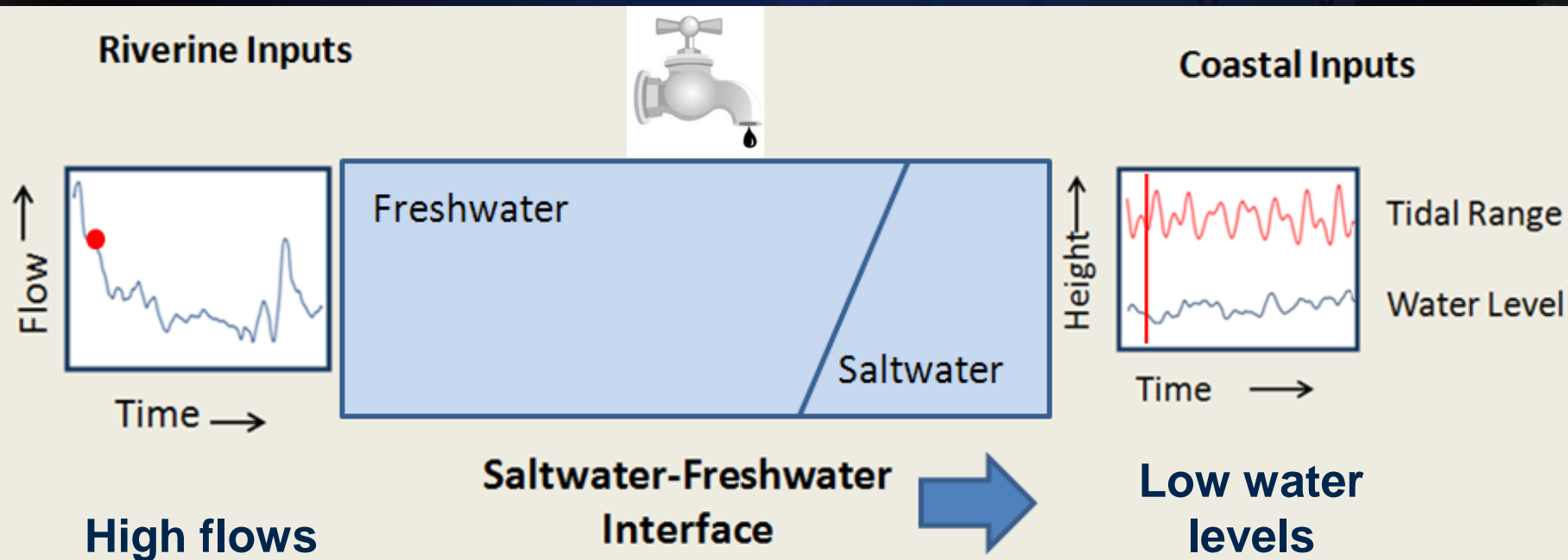
Short Review Salinity Dynamics



“...estuaries may never really be steady-state systems; they may be trying to reach a balance they never achieve.”

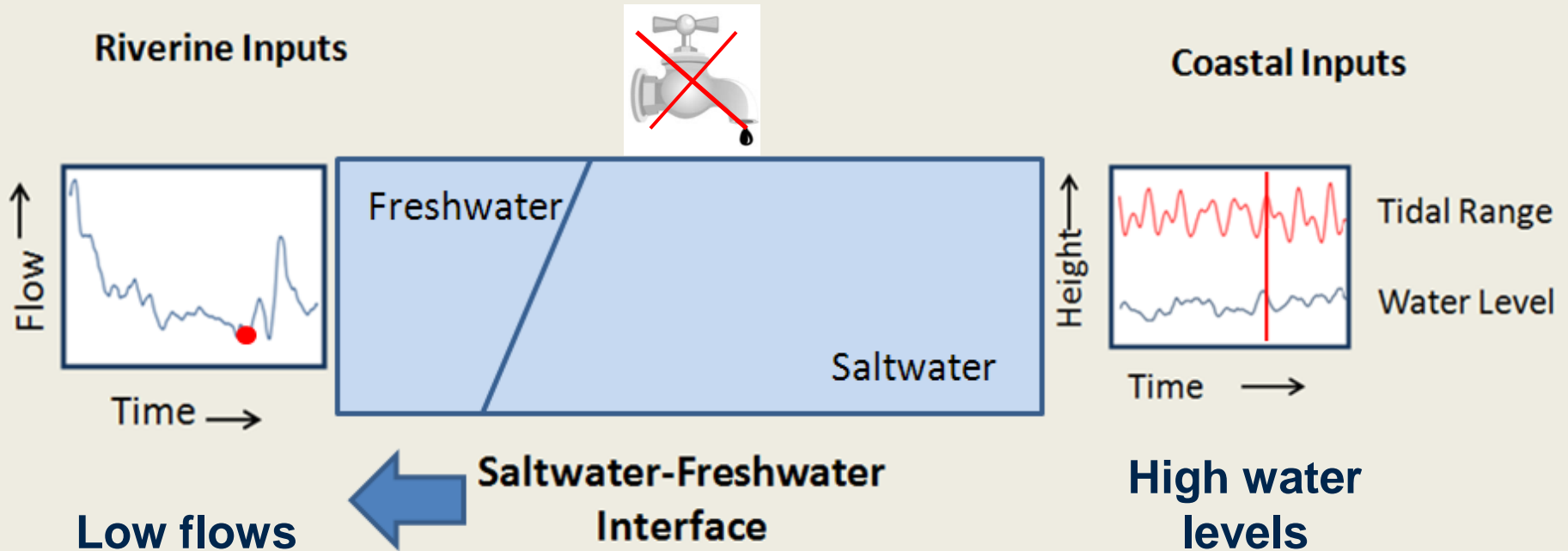
Keith Dyer, from Estuaries – A Physical Introduction (1997)

Saltwater-Freshwater Interface



**Freshwater
Communities**

Saltwater-Freshwater Interface



**Brackish
Communities**

Look at Some Data

Freshwater



Saltwater



Riverine Flows

Savannah River
at Clio

Specific
conductance

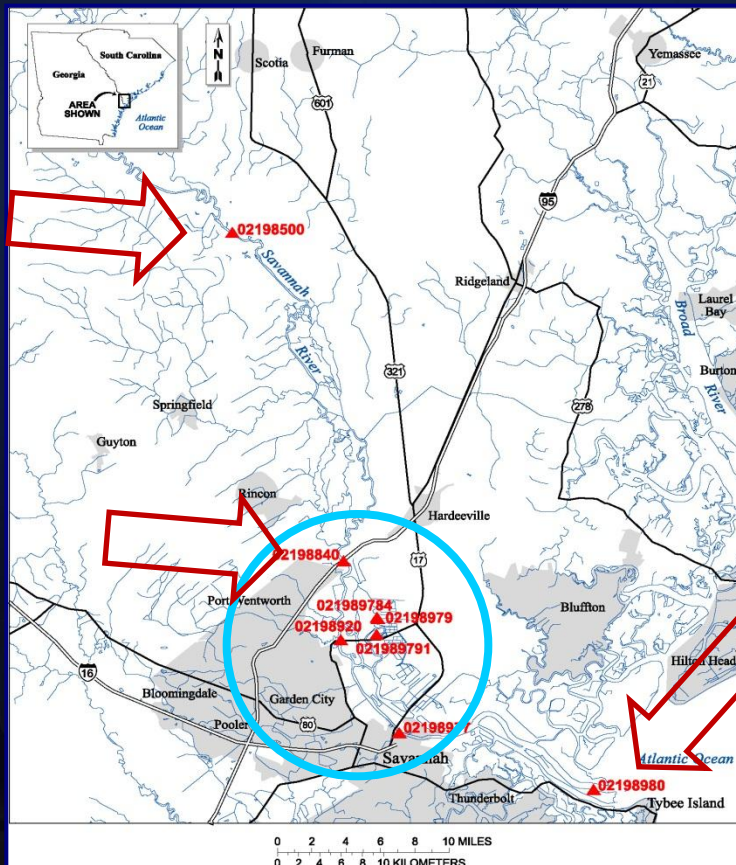
I-95

Tidal Forcing

Coastal Water
level

Tidal Range

Fort Pulaski

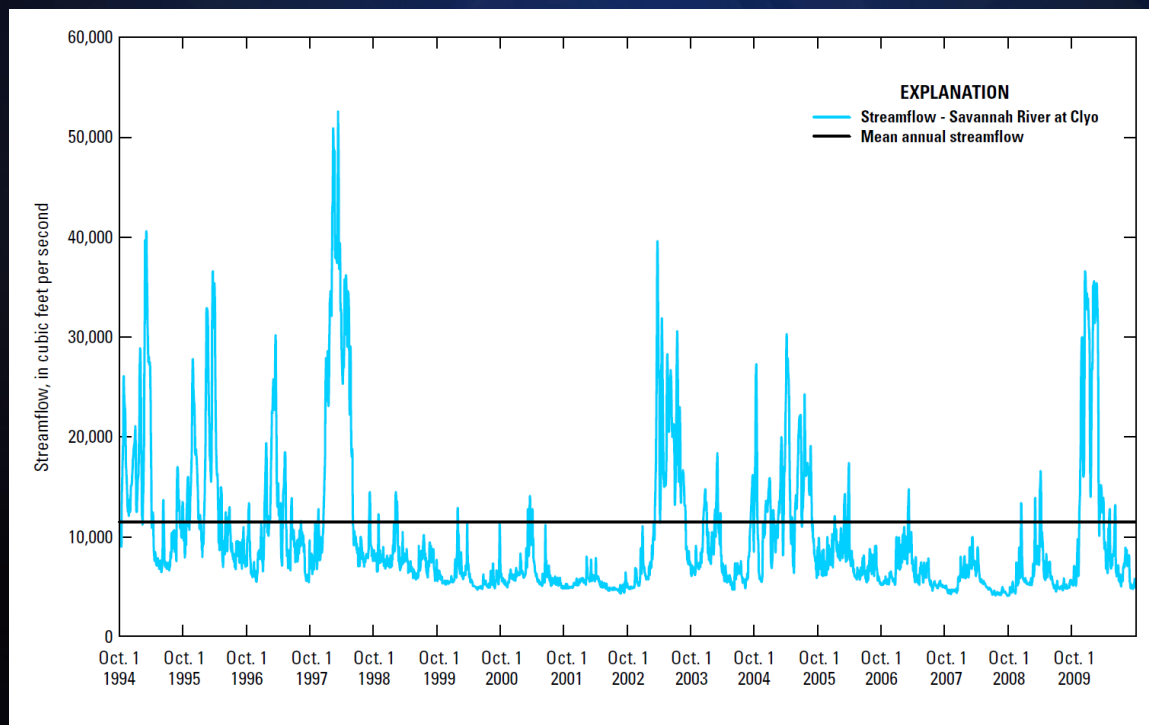


Savannah River Flows

Riverine
Flow



Tidal Forcing
mean water
level, tidal
range



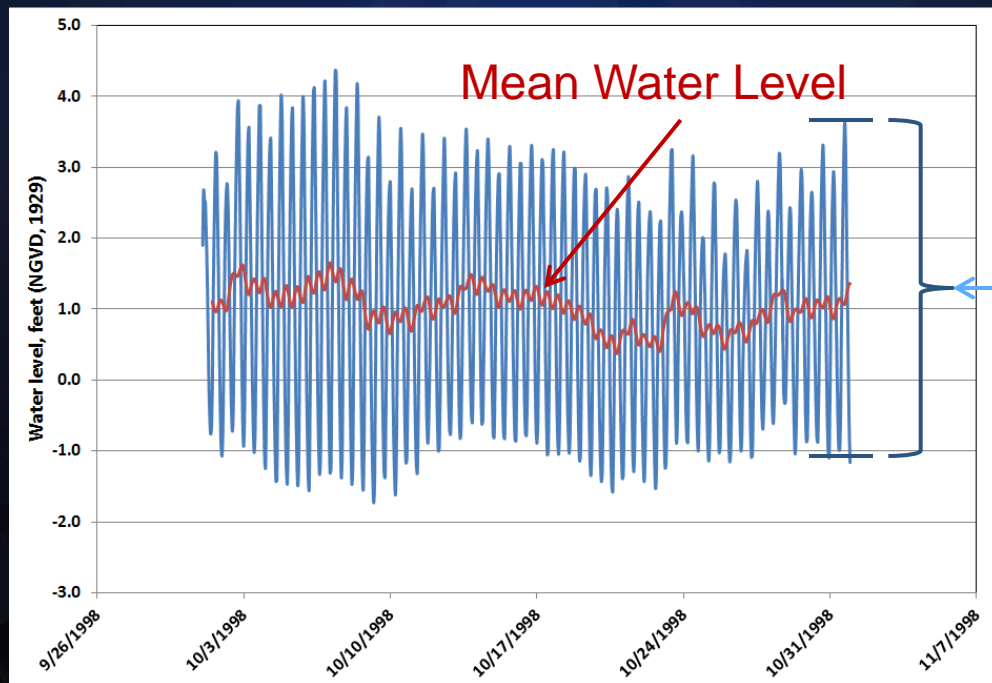
Example of Data: Water level

Riverine
Flow



Tidal Forcing
mean water
level, tidal
range

Two signals:
Mean water
level & Tidal
Range

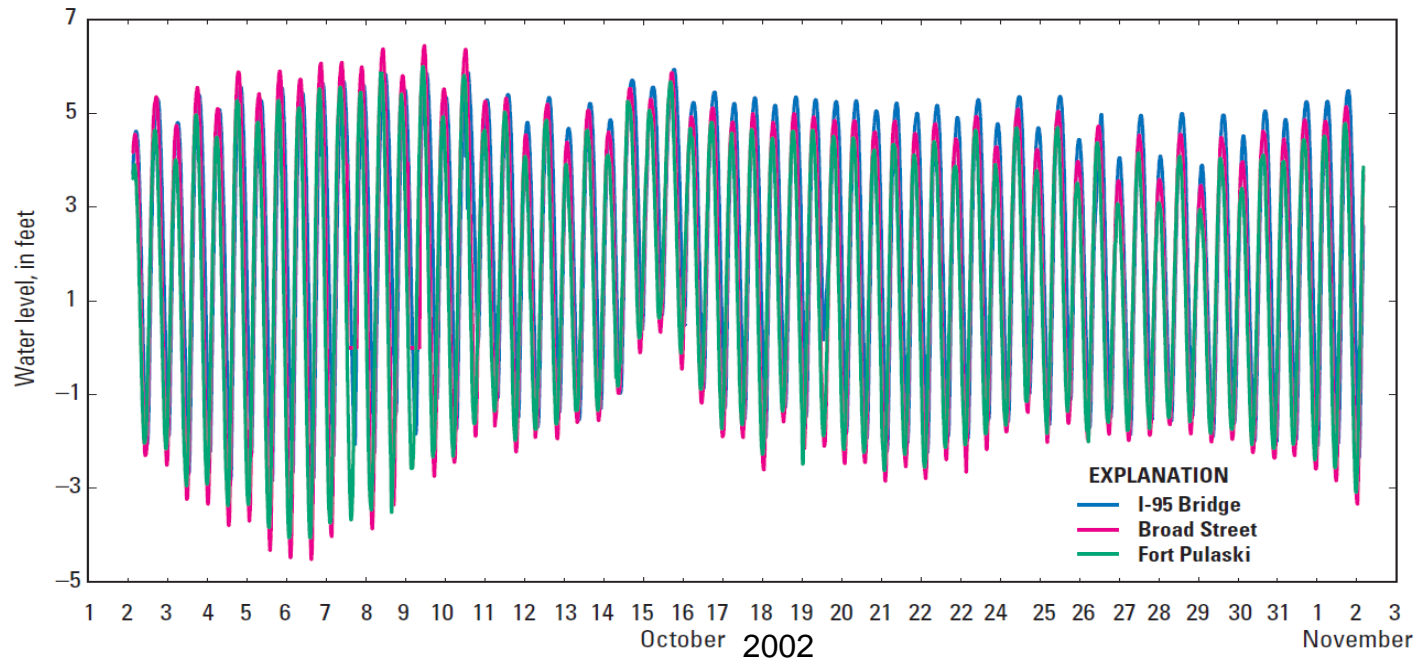


Savannah Harbor Water Levels

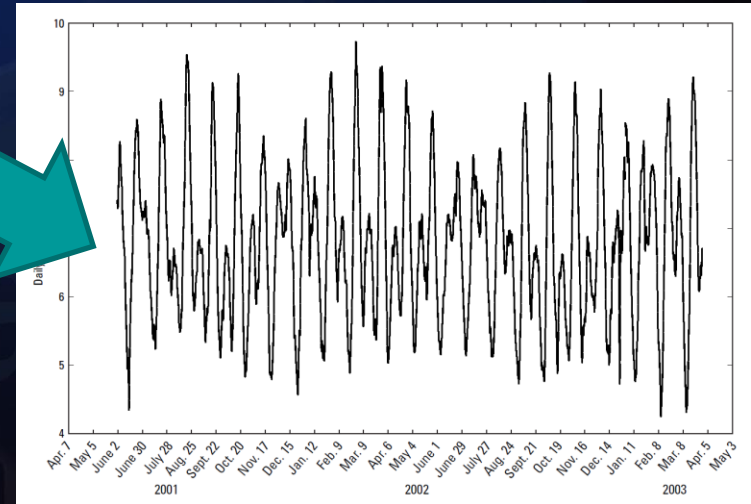
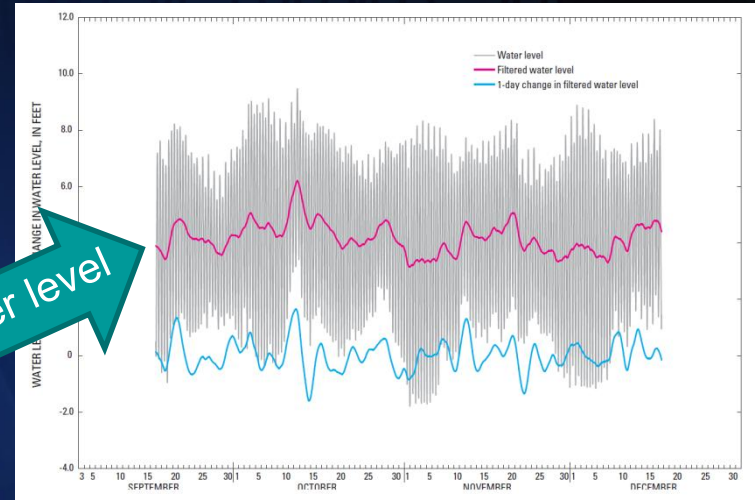
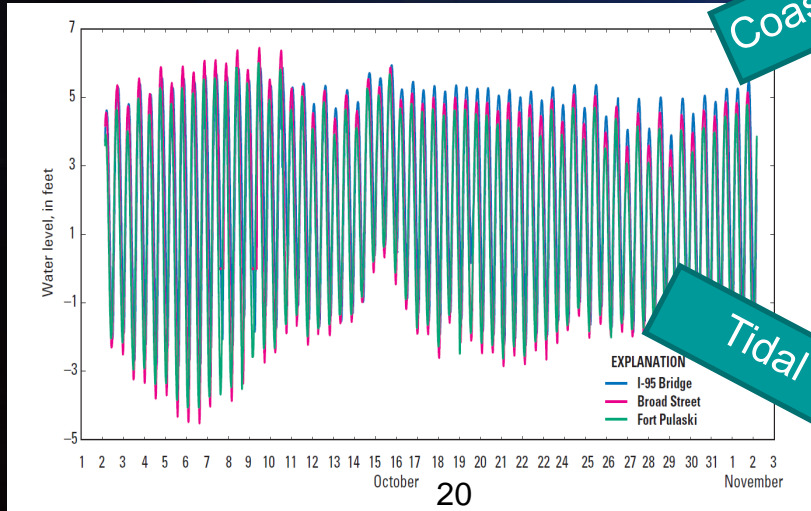
Riverine
Flow



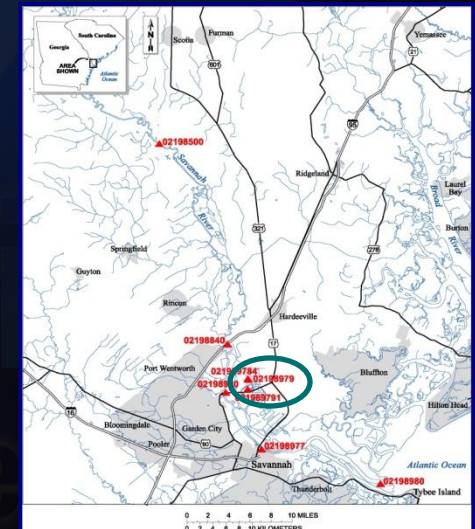
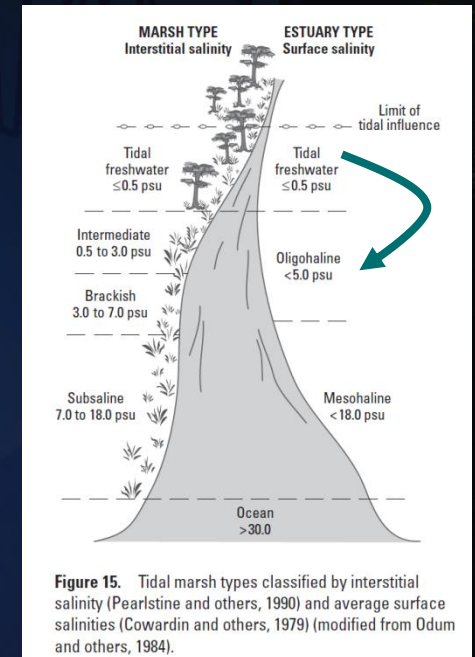
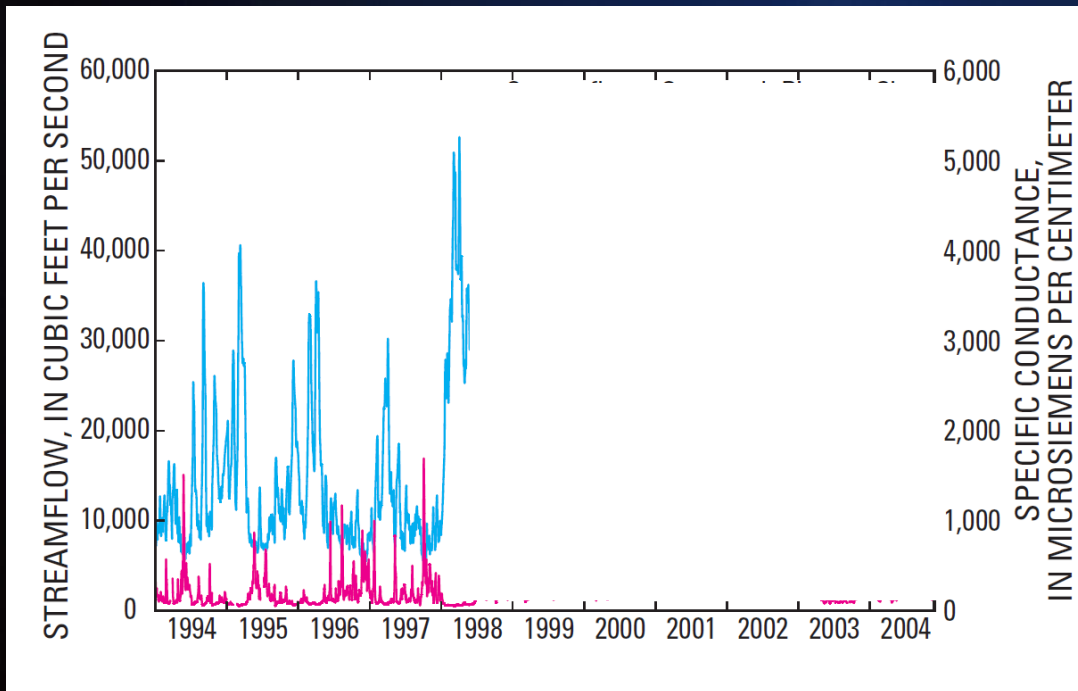
Tidal Forcing
mean water
level, tidal
range



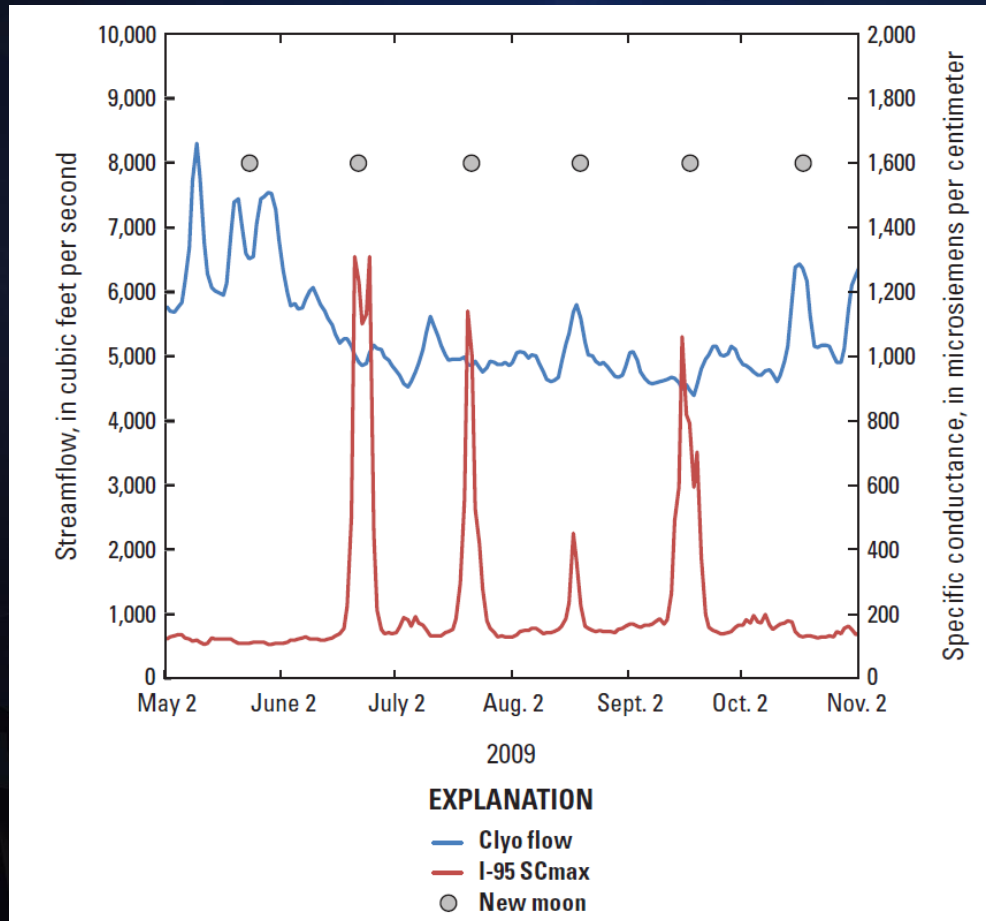
Decomposed Water Level Signals



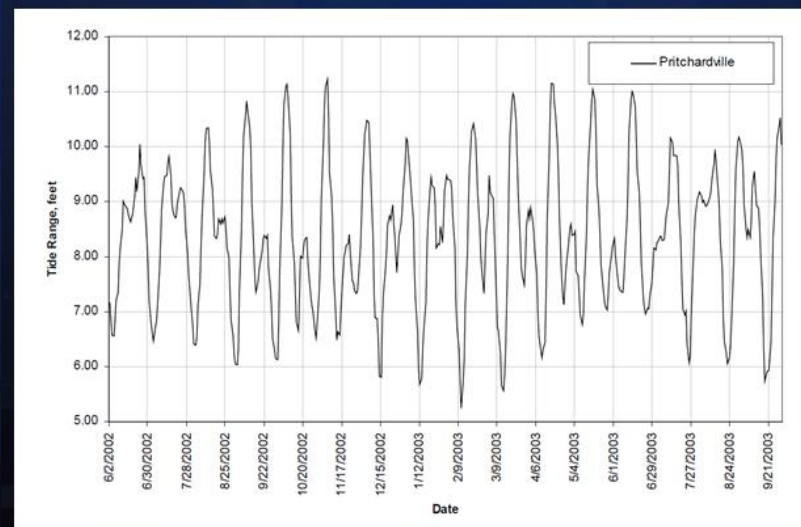
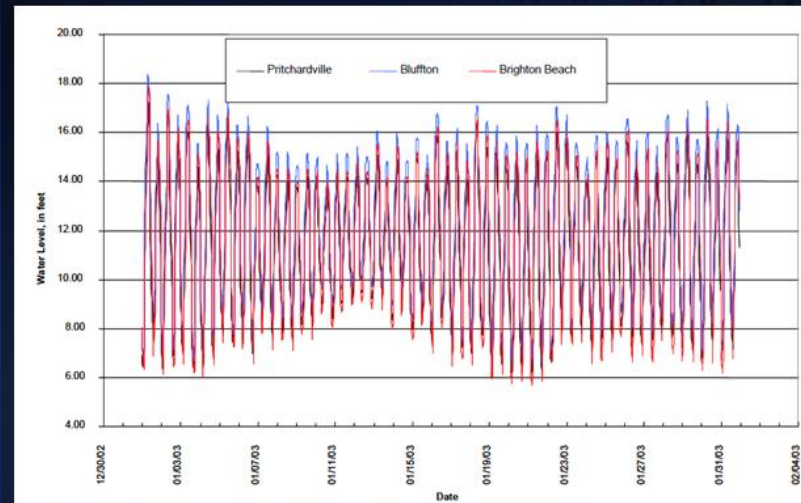
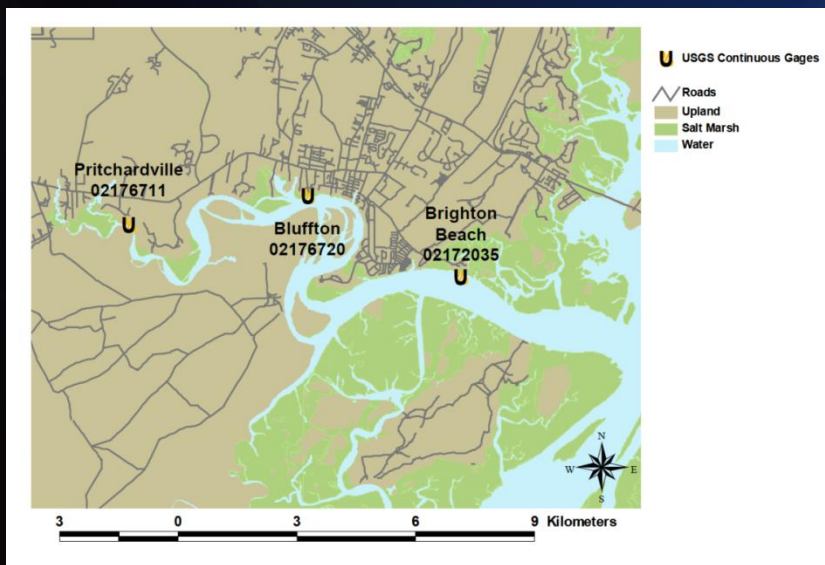
Salinity Response



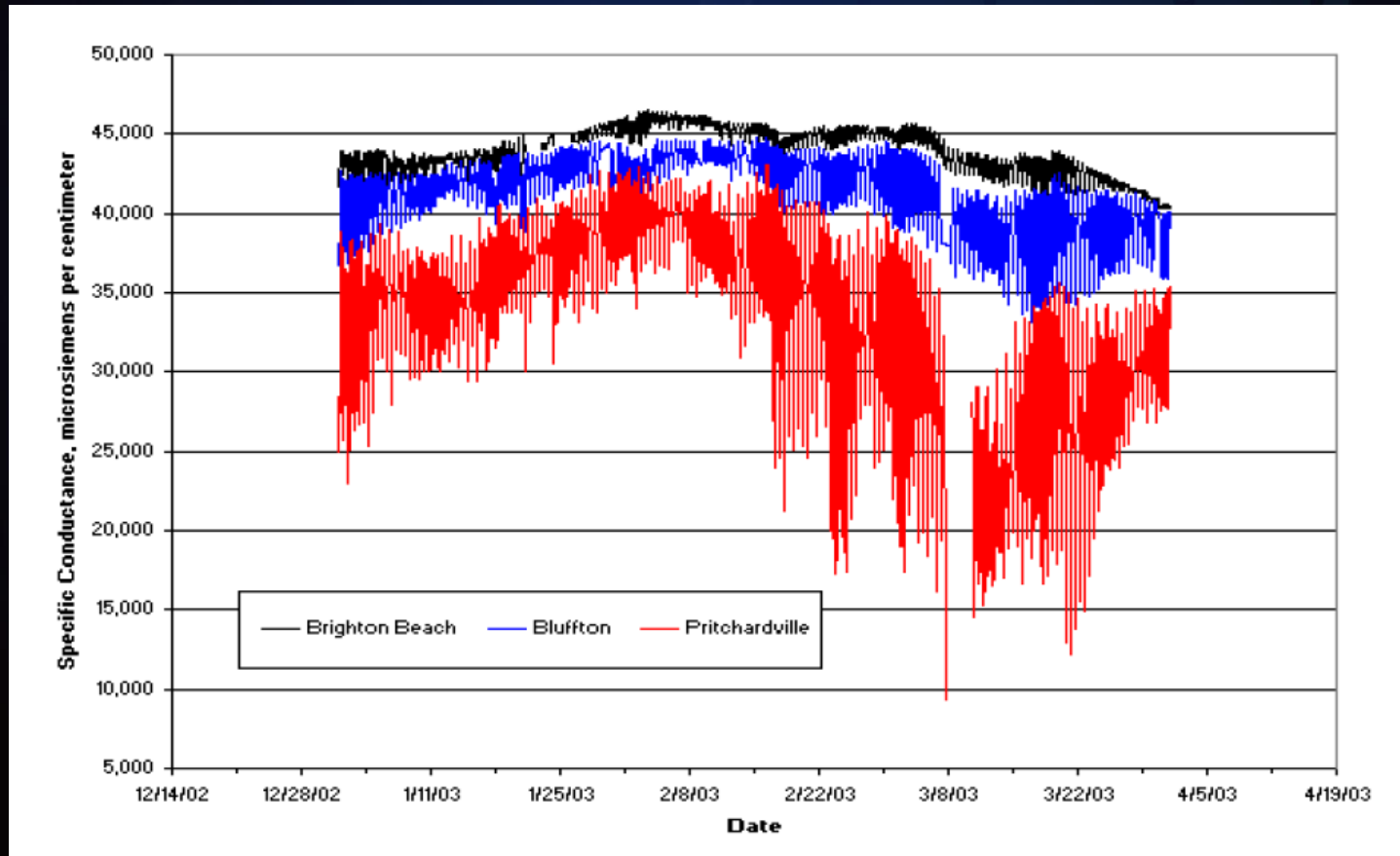
Converging Conditions: Savannah River



May River



Salinity Response



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Rivers vs. Tidal Sloughs

Rainfall



Riverine
Flow



Tidal Forcing
mean water
level, tidal
range

Rivers: Salinity Intrusion

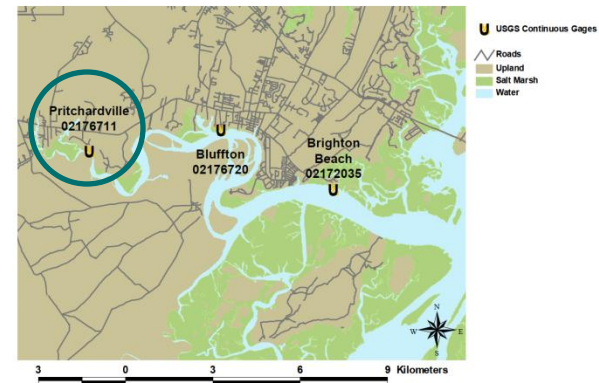
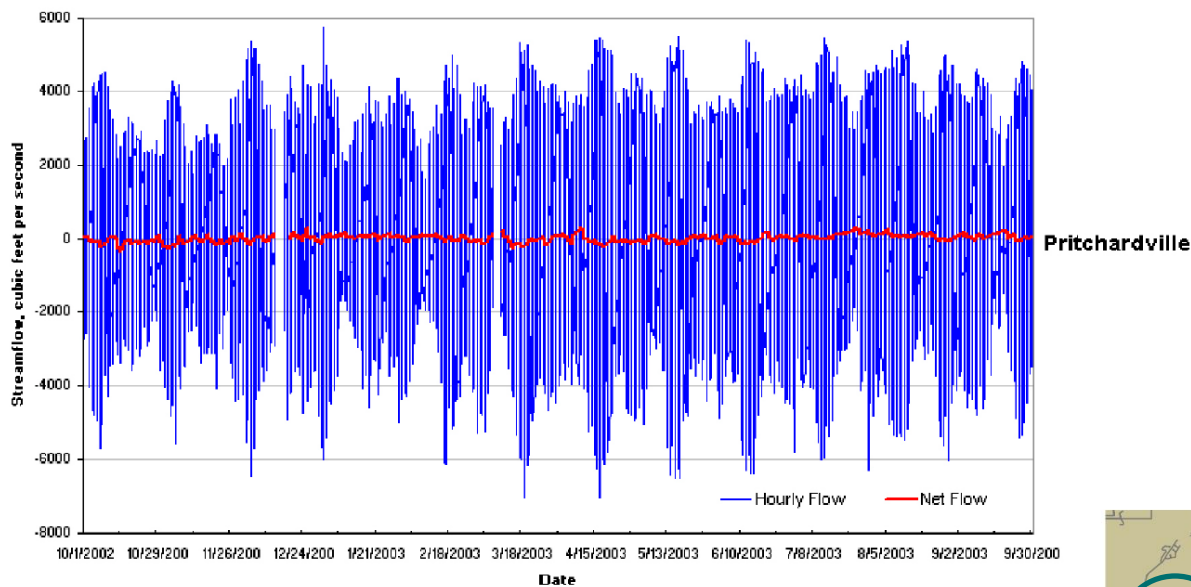
Rainfall



Tidal Forcing
mean water
level, tidal
range

Sloughs: Salinity Dilution

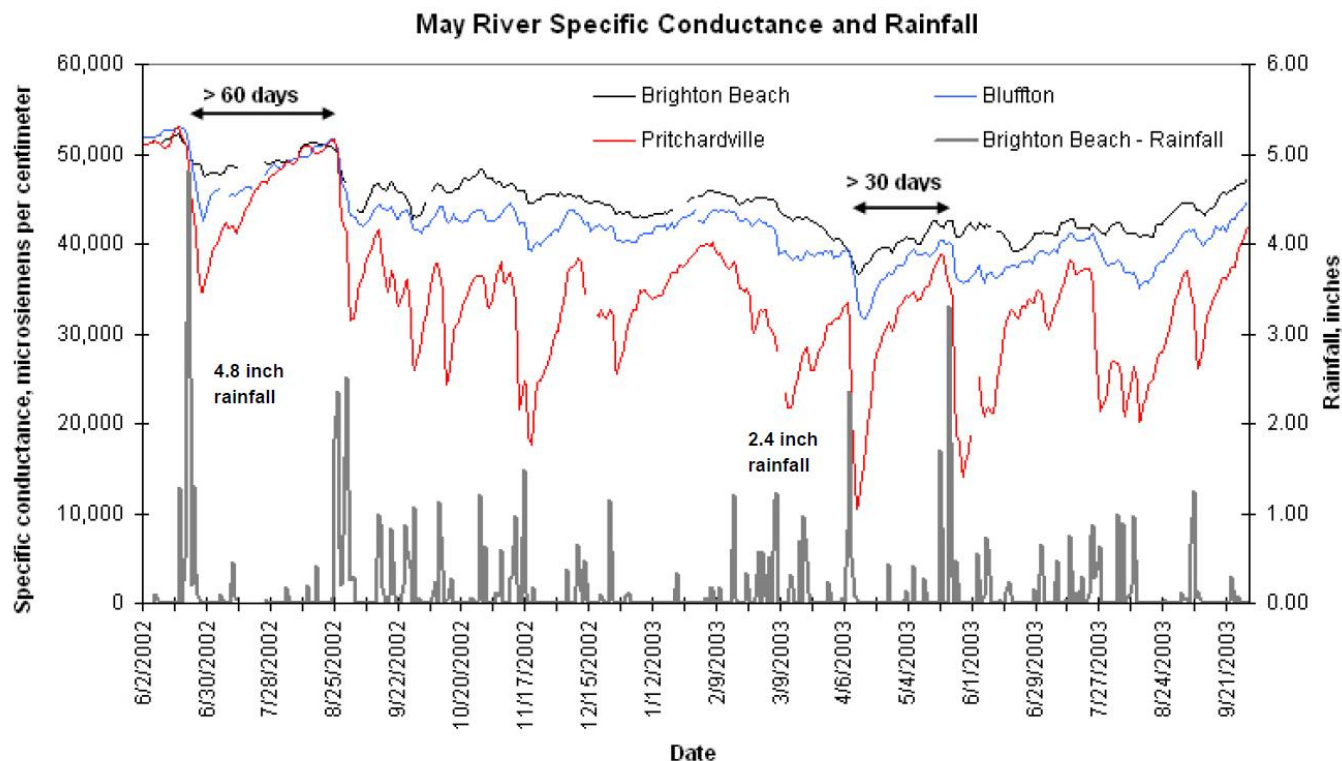
May River Tidal Flows



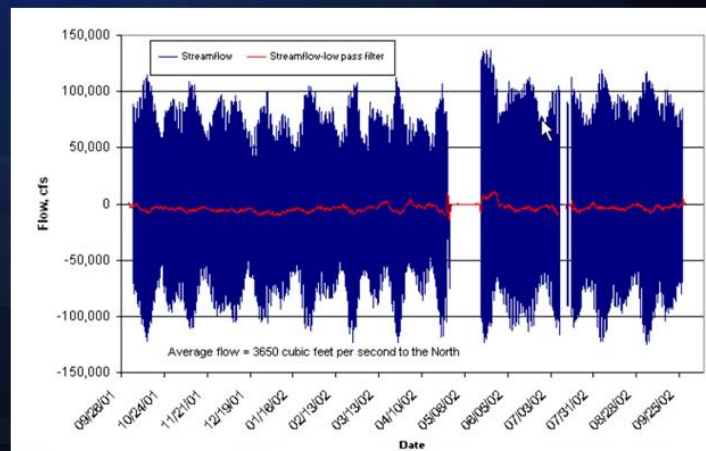
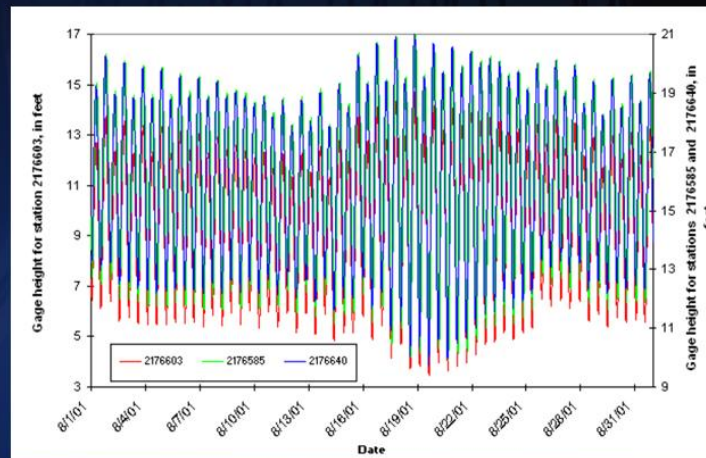
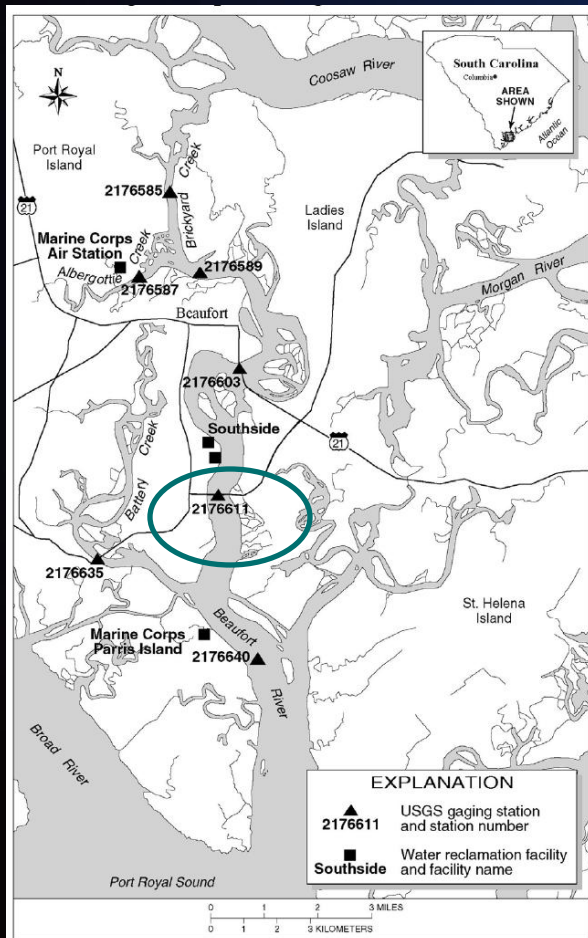
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Specific Conductance and Rainfall

May River

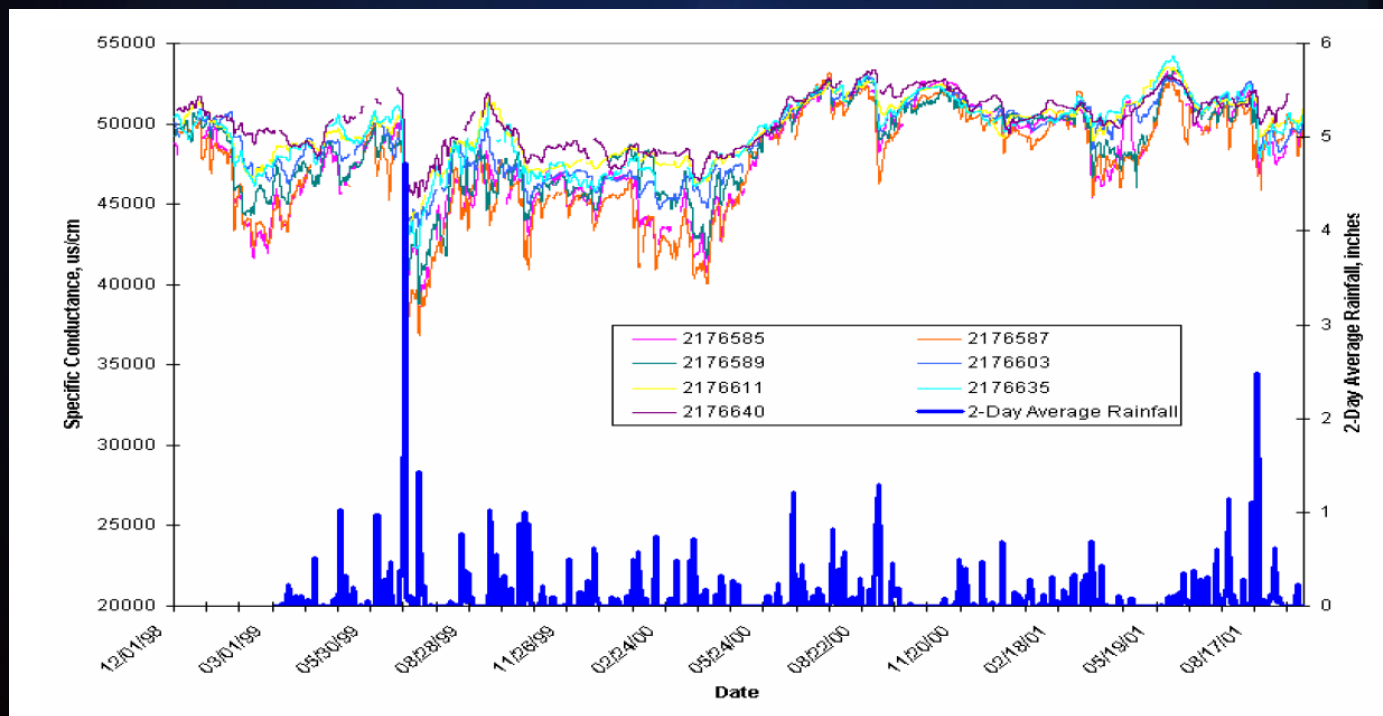


Beaufort River Tidal Connector



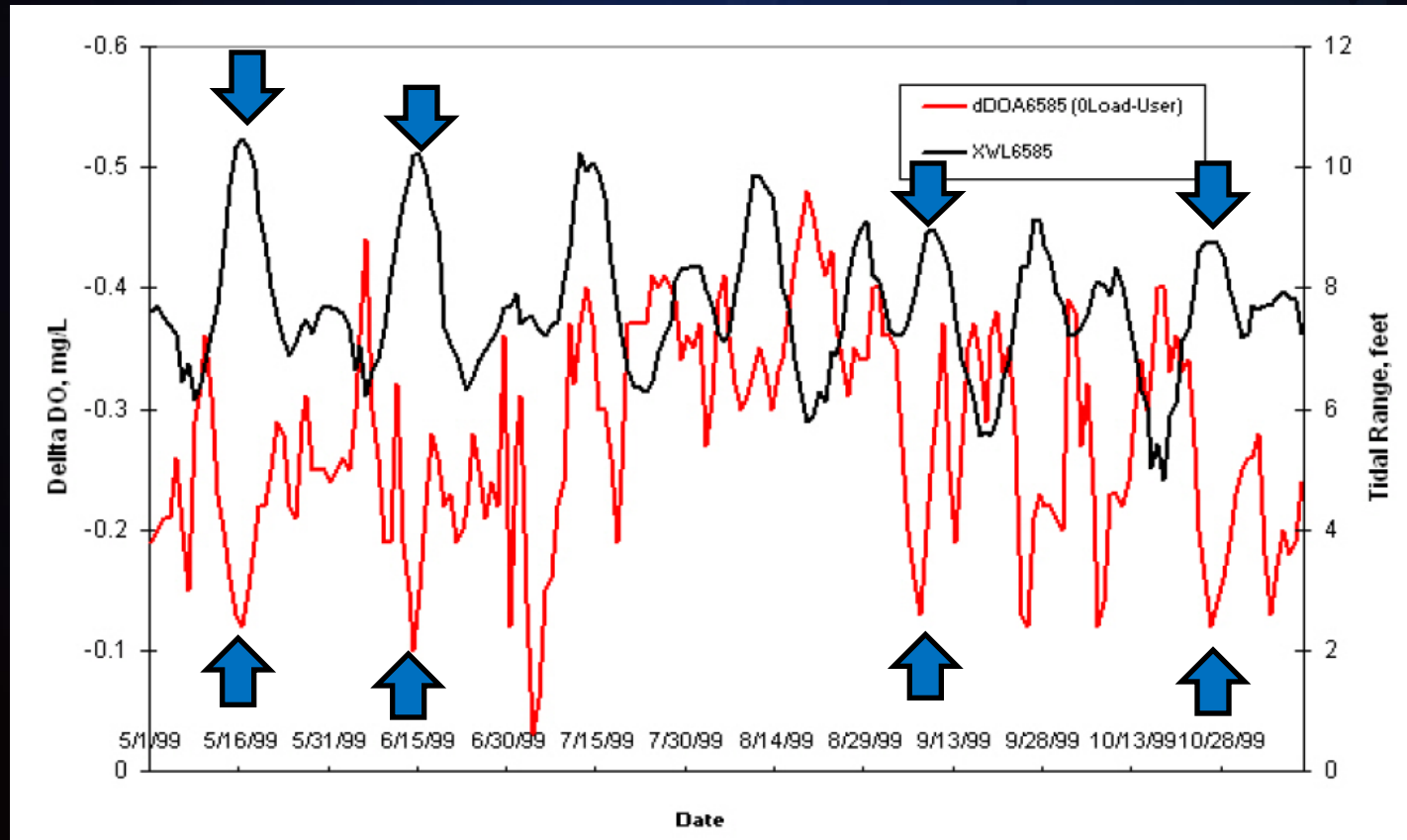
Specific Conductance and Rainfall

Beaufort River



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Mixing Implications Beaufort River



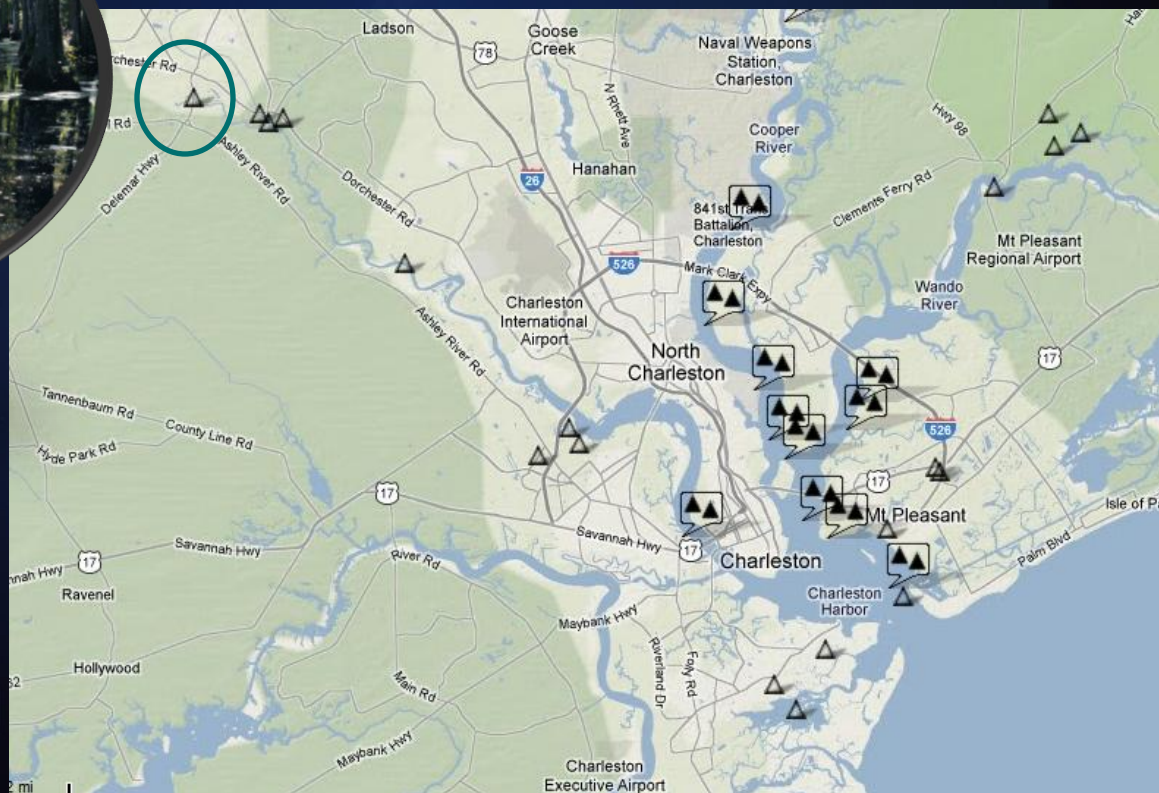
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Ashley River



Cypress Swamp

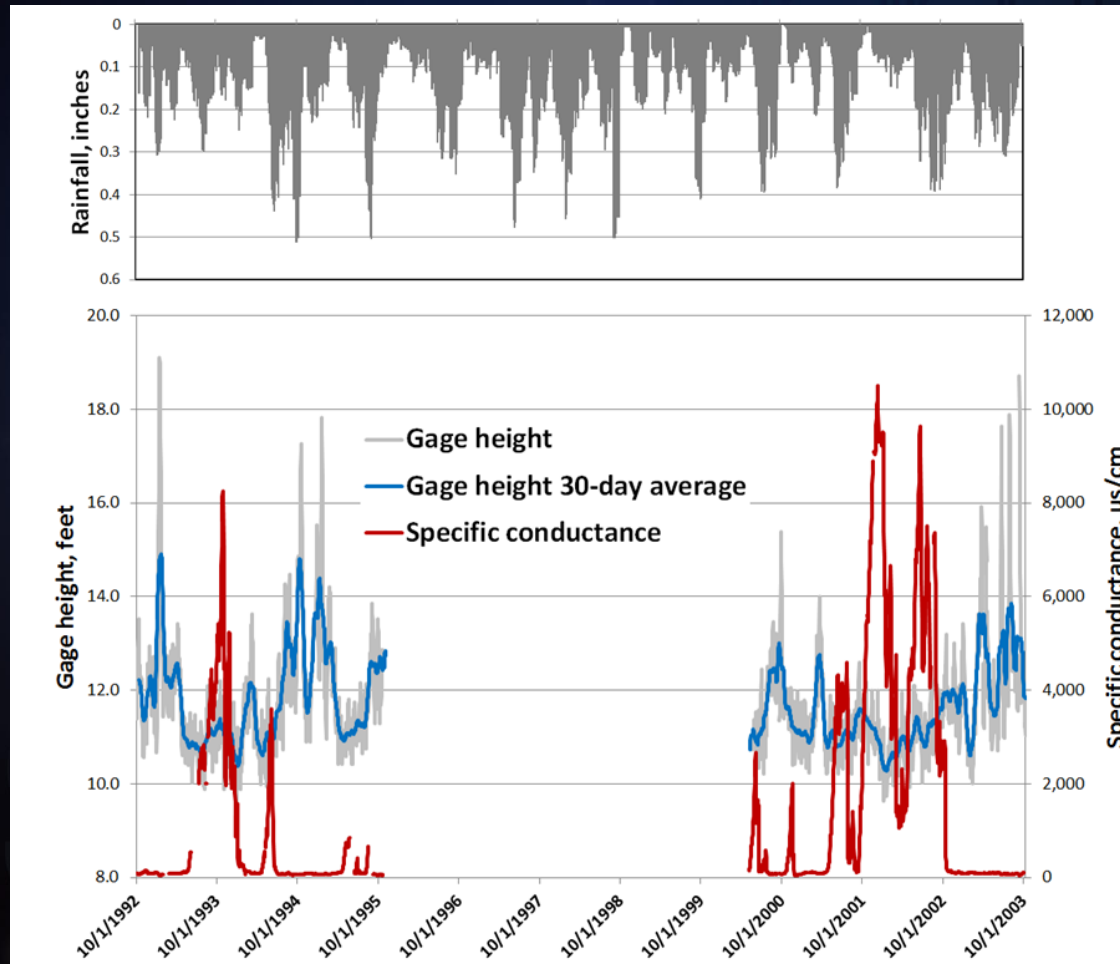
Cooke Crossroads



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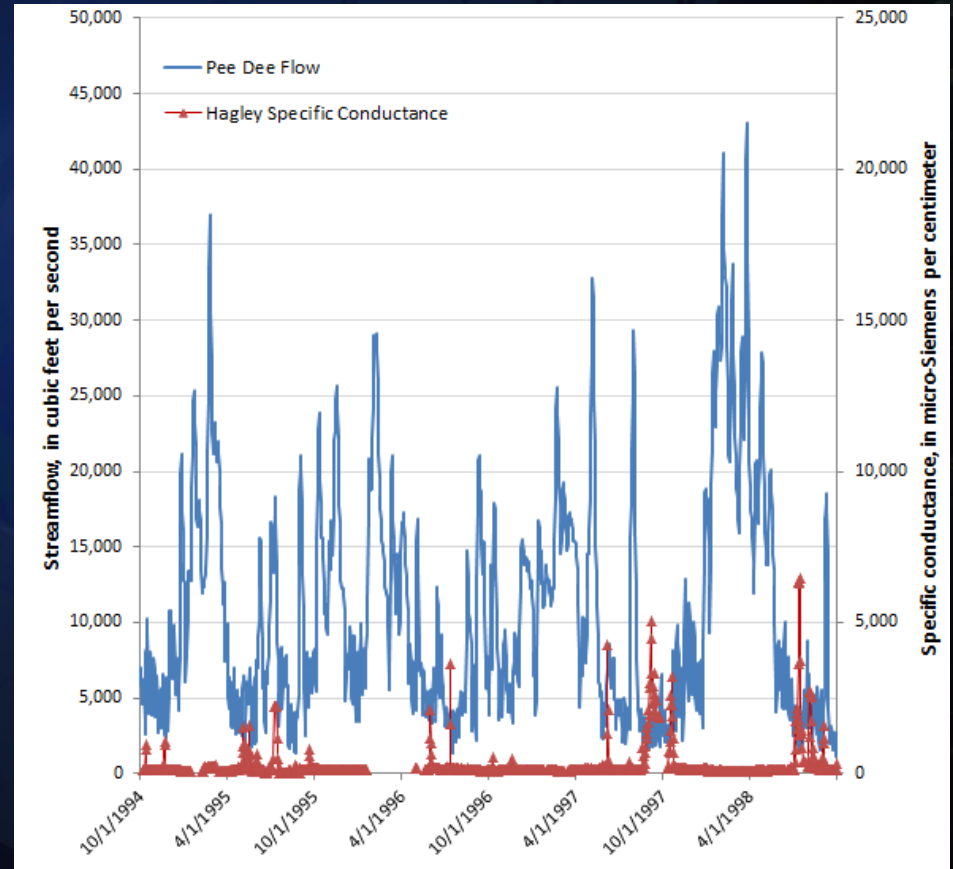
Specific Conductance and Rainfall

Ashley River



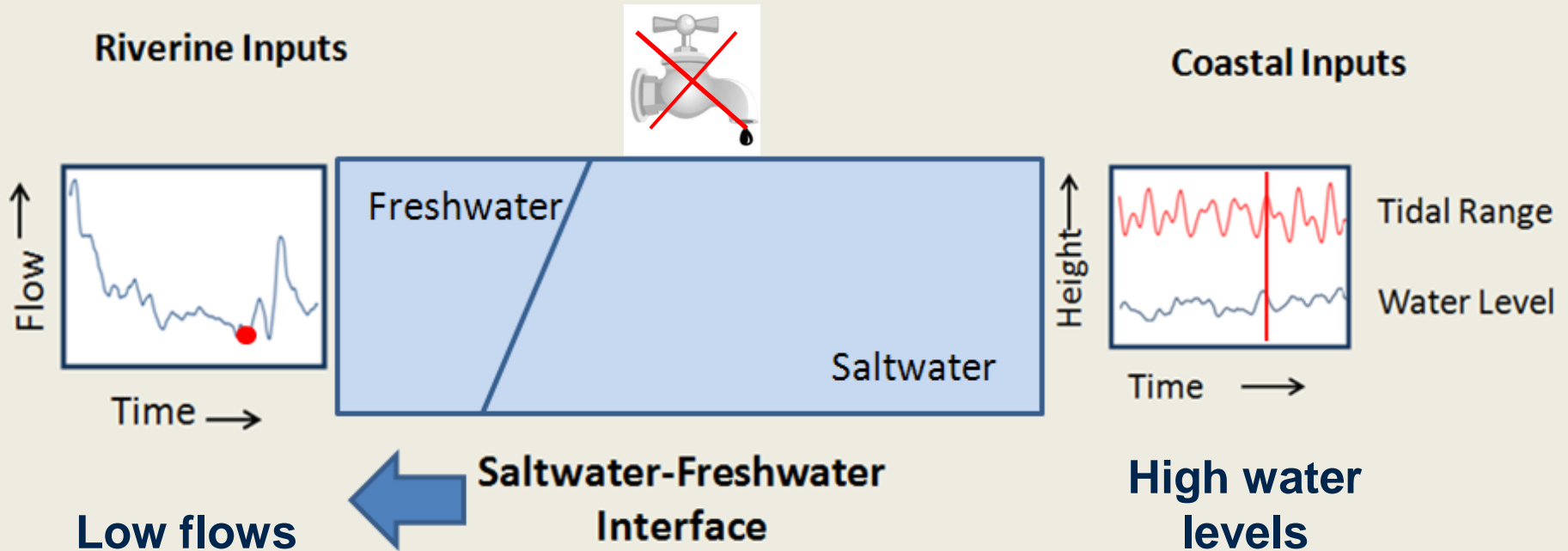
Pee Dee River

Waccamaw River at Hagley Landing



Water Science Center 1994-1998

Pity the Water Intake

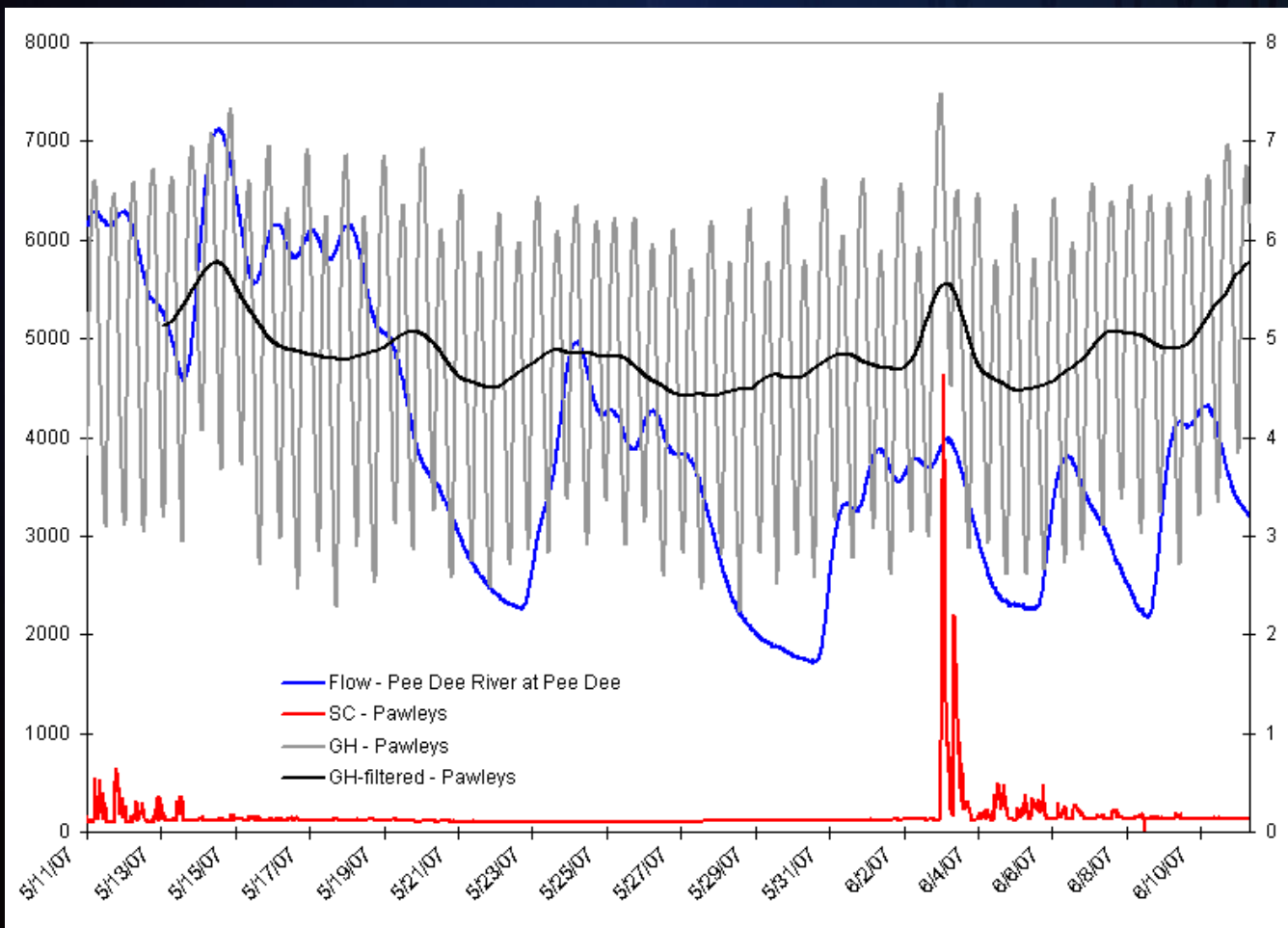


**Brackish
Communities**

Converging Conditions

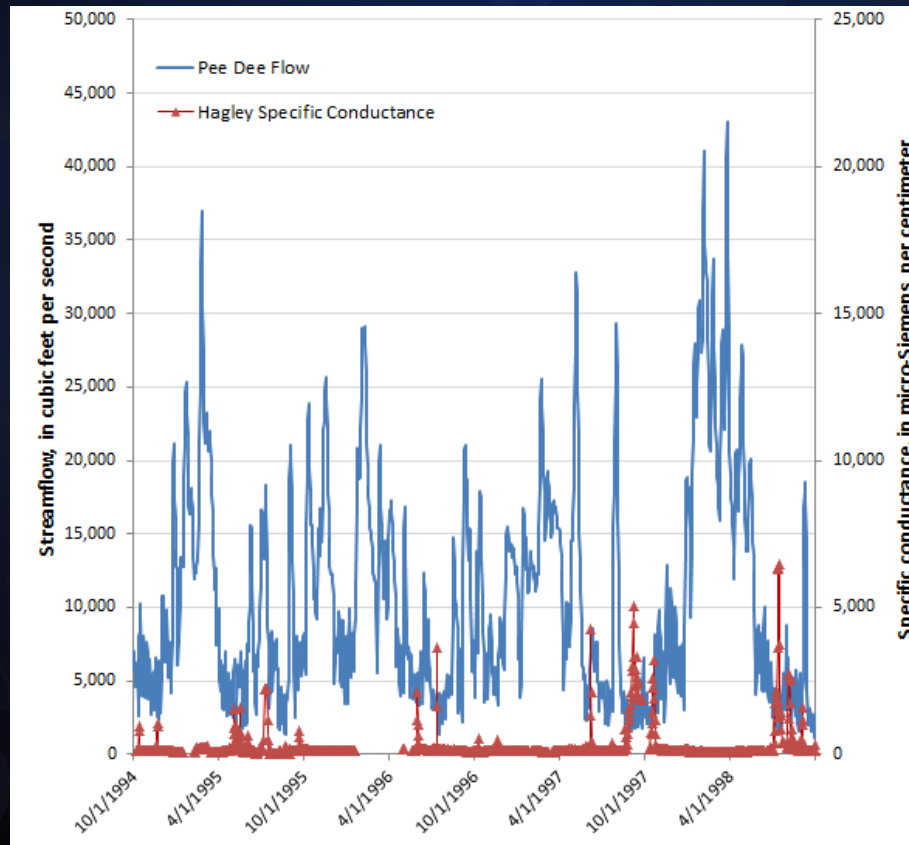
Pee Dee & Waccamaw Rivers

SPECIFIC CONDUCTANCE, UG/CM and FLOW, FT³/S



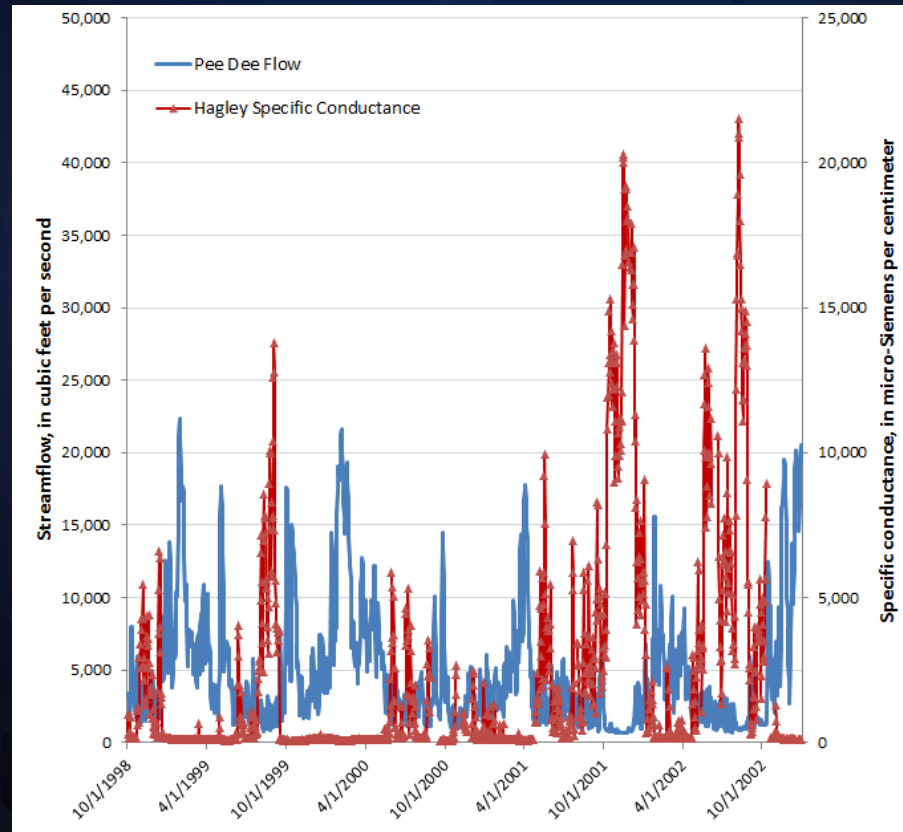
GAGE HEIGHTS AND FILTERED GAGES HEIGHT, FEET

Pee Dee River Waccamaw River at Hagley Landing



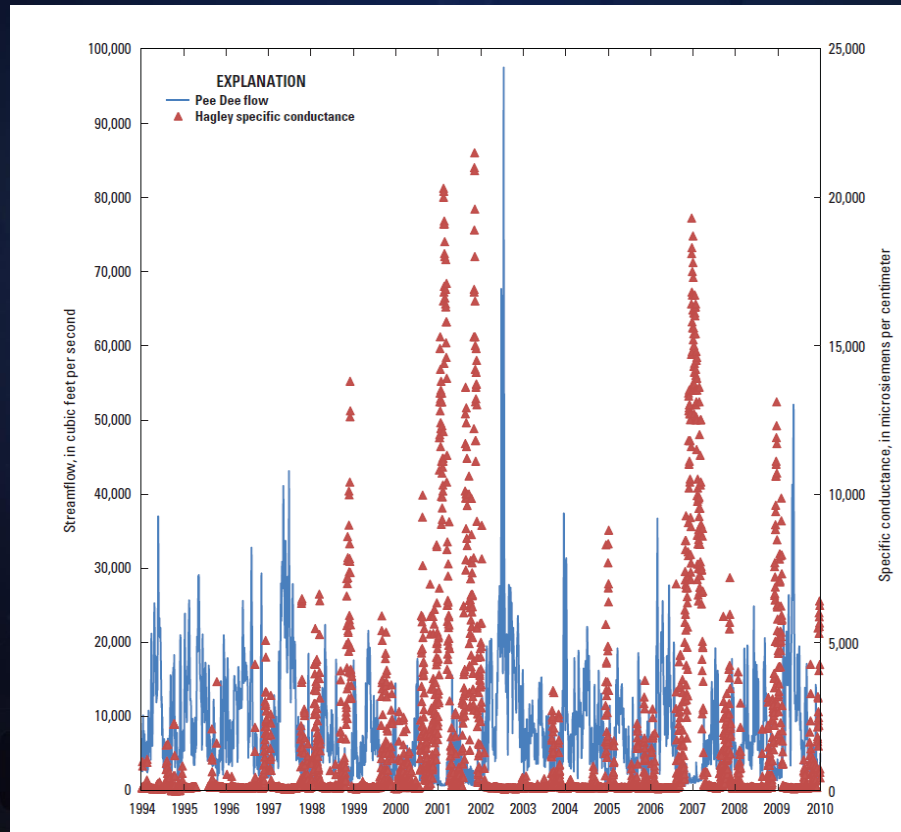
1994-1998

Pee Dee River Waccamaw River at Hagley Landing



1998-2002

Pee Dee River Waccamaw River at Hagley Landing



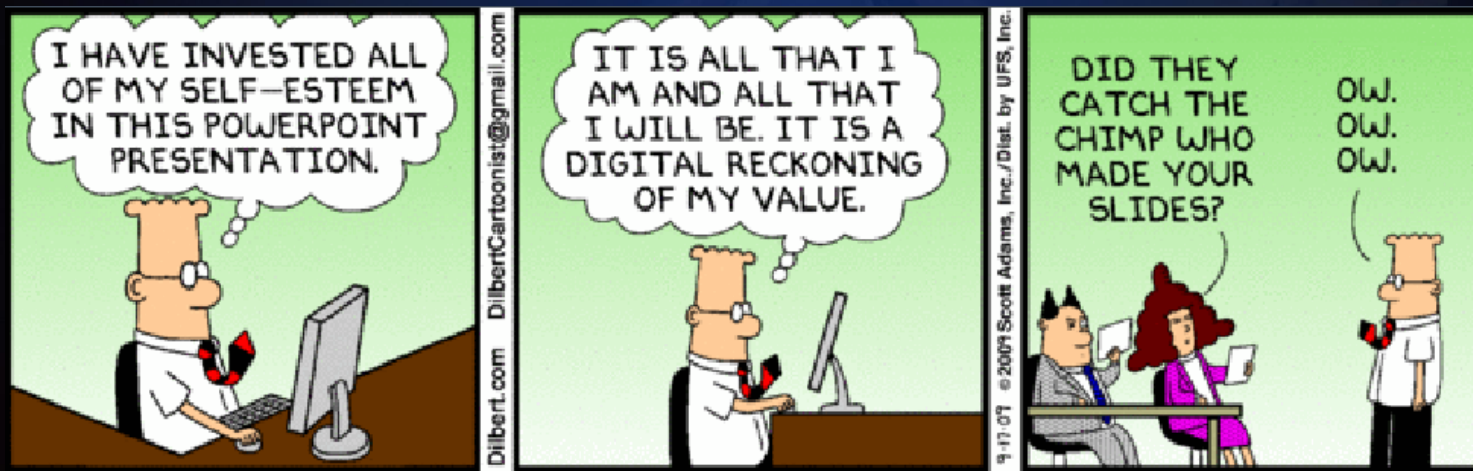
1994-2010

Conclusions

- Few (if any) natural coastal estuarine system
- Climate affects flows and coastal water levels
- Salinity dynamics results from complex flow and water level interaction
- Flow alterations (i.e. regulation and land-use change) can effect salinity as much as climate variability
- Salinity shift – large affect on ecological community and infrastructure availability

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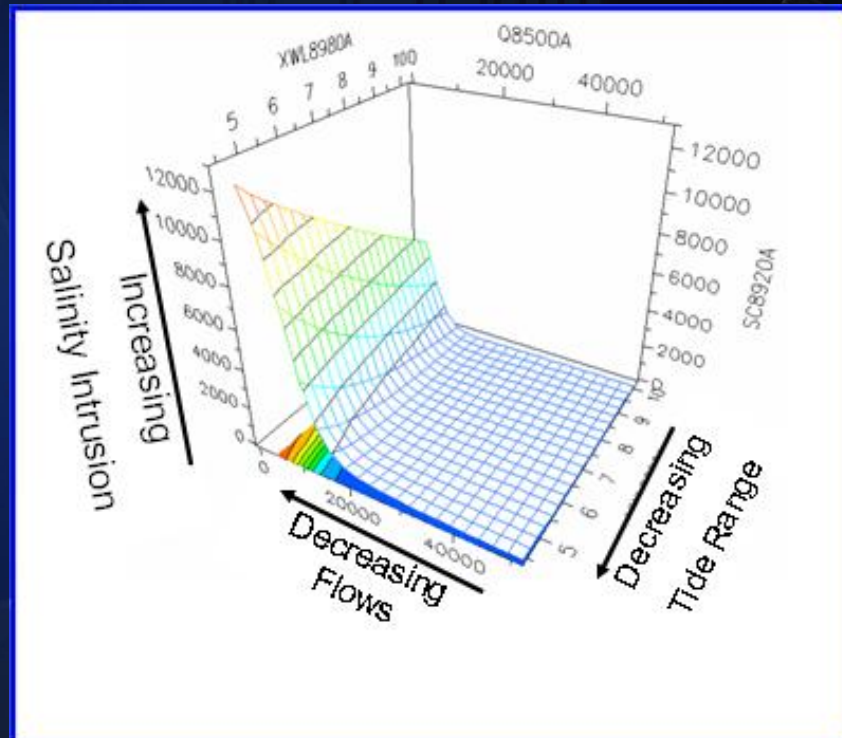


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Looking Inside the Black Box

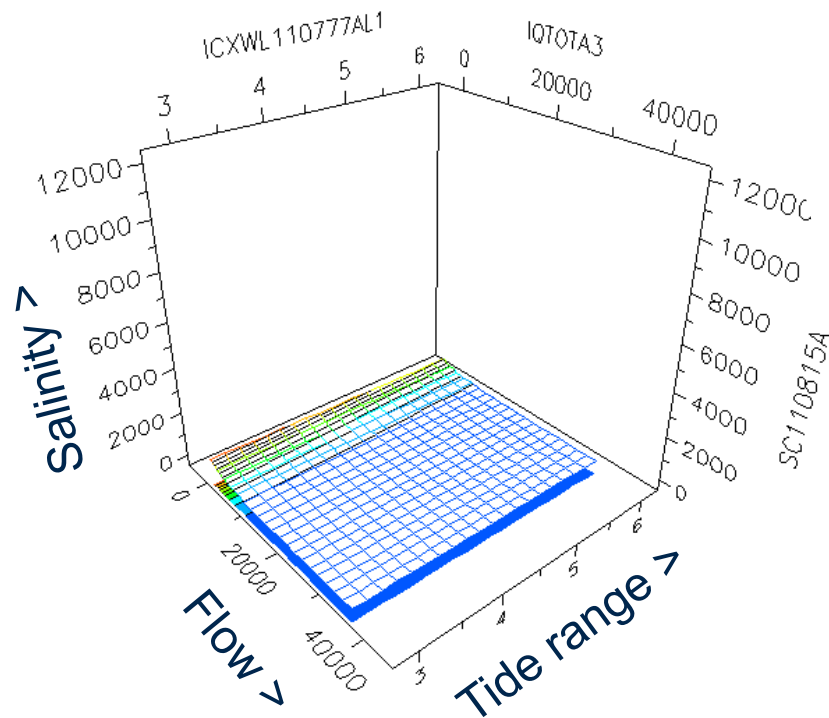
- 3D response surfaces
 - Surface created by model
 - “Unseen” variables set to constant value
 - Manifestation of historical behavior of system
 - Insight to the process dynamics or physics



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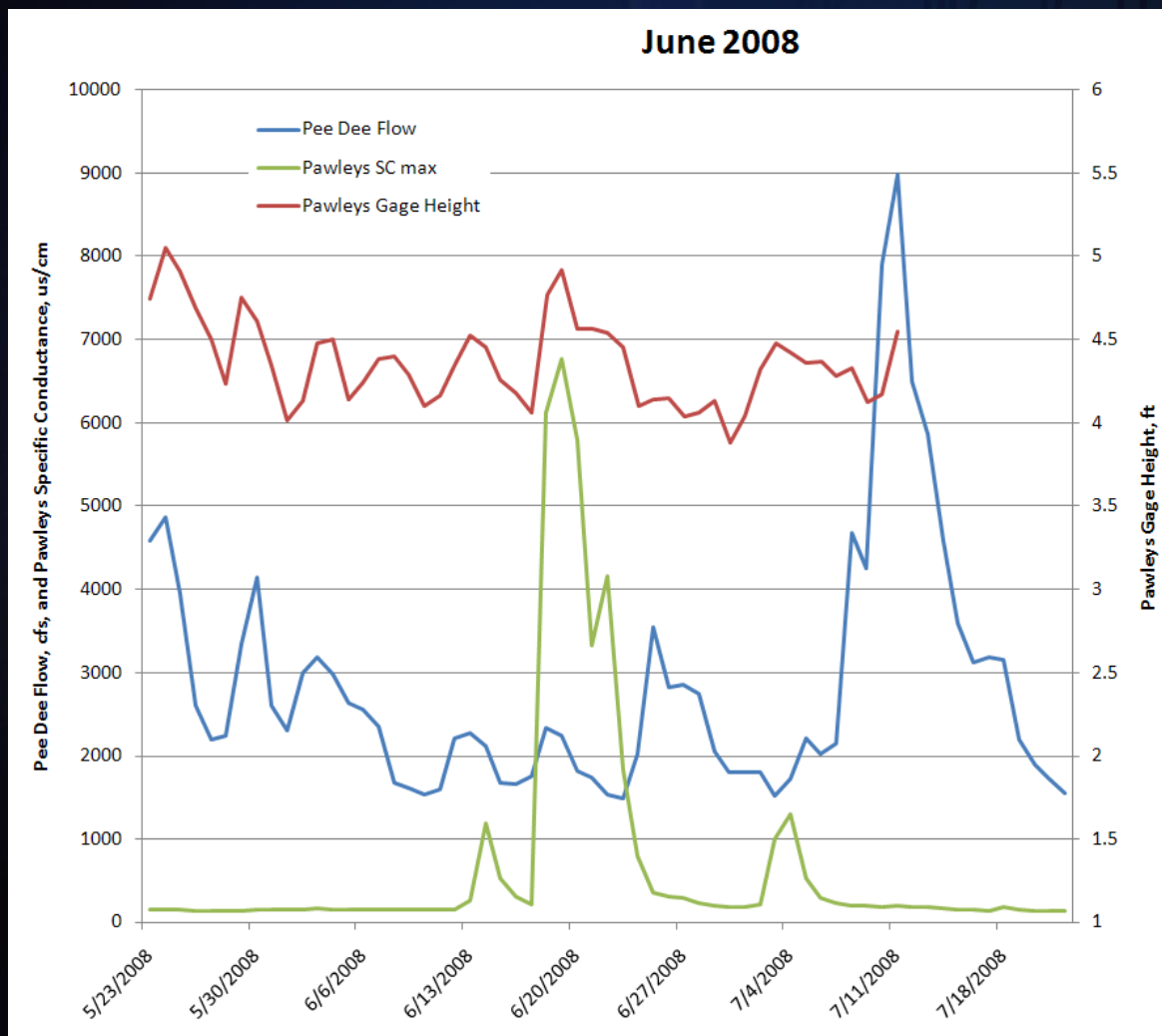
What Conditions Cause Large Intrusions?

3-D Response surface – Flow, Tidal Range, and Salinity

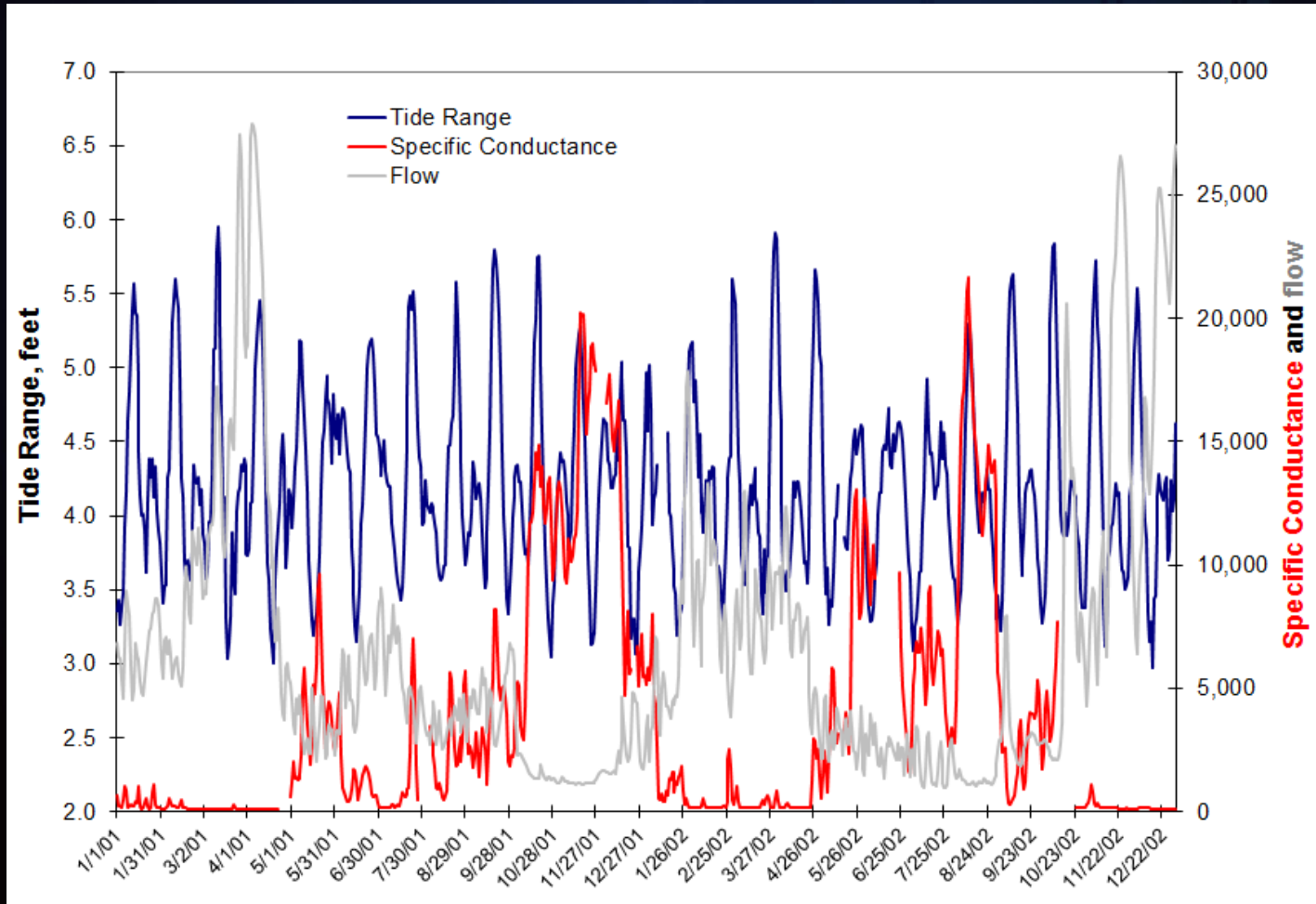


Low Coastal Water Level

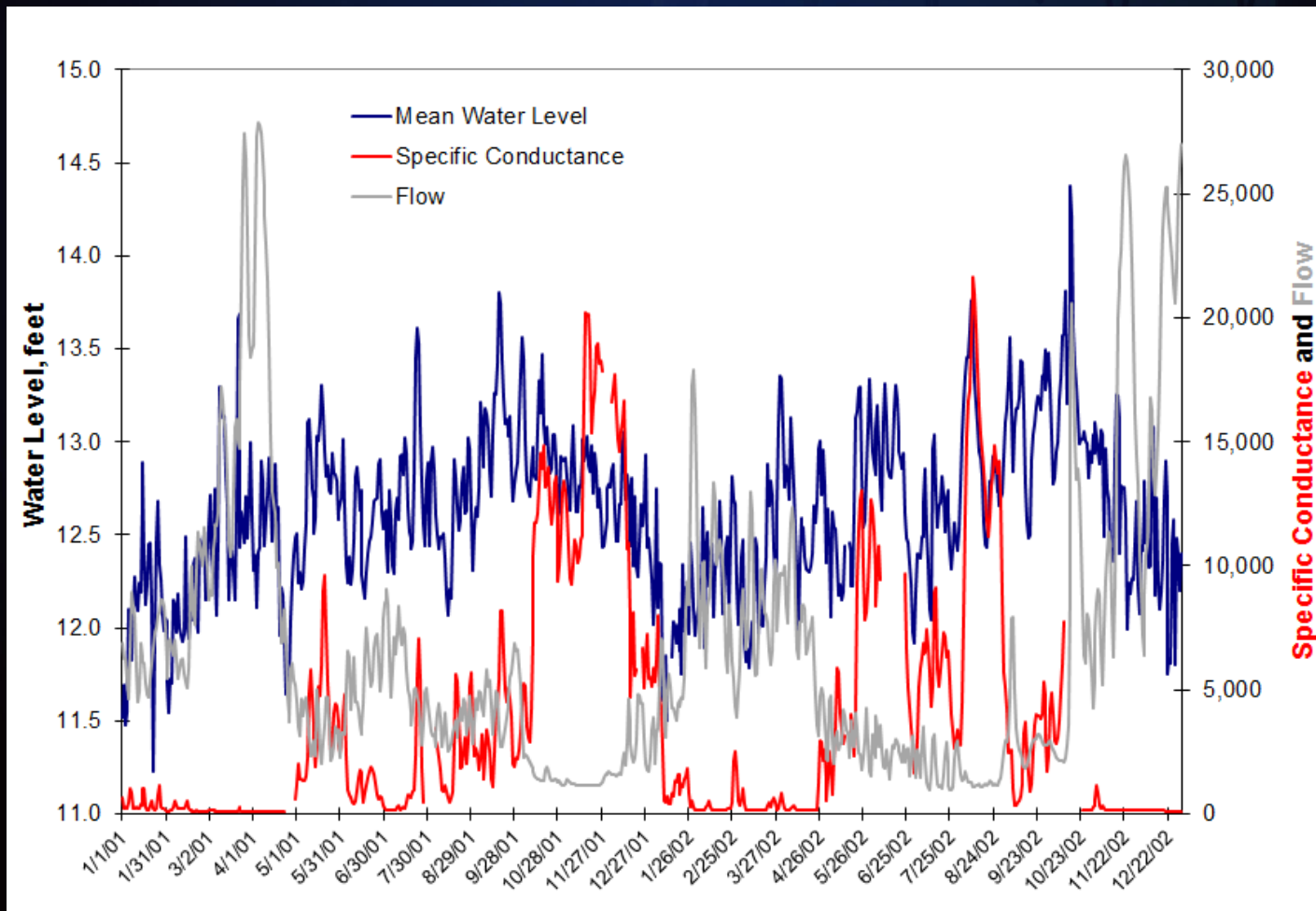
Convergence of Conditions



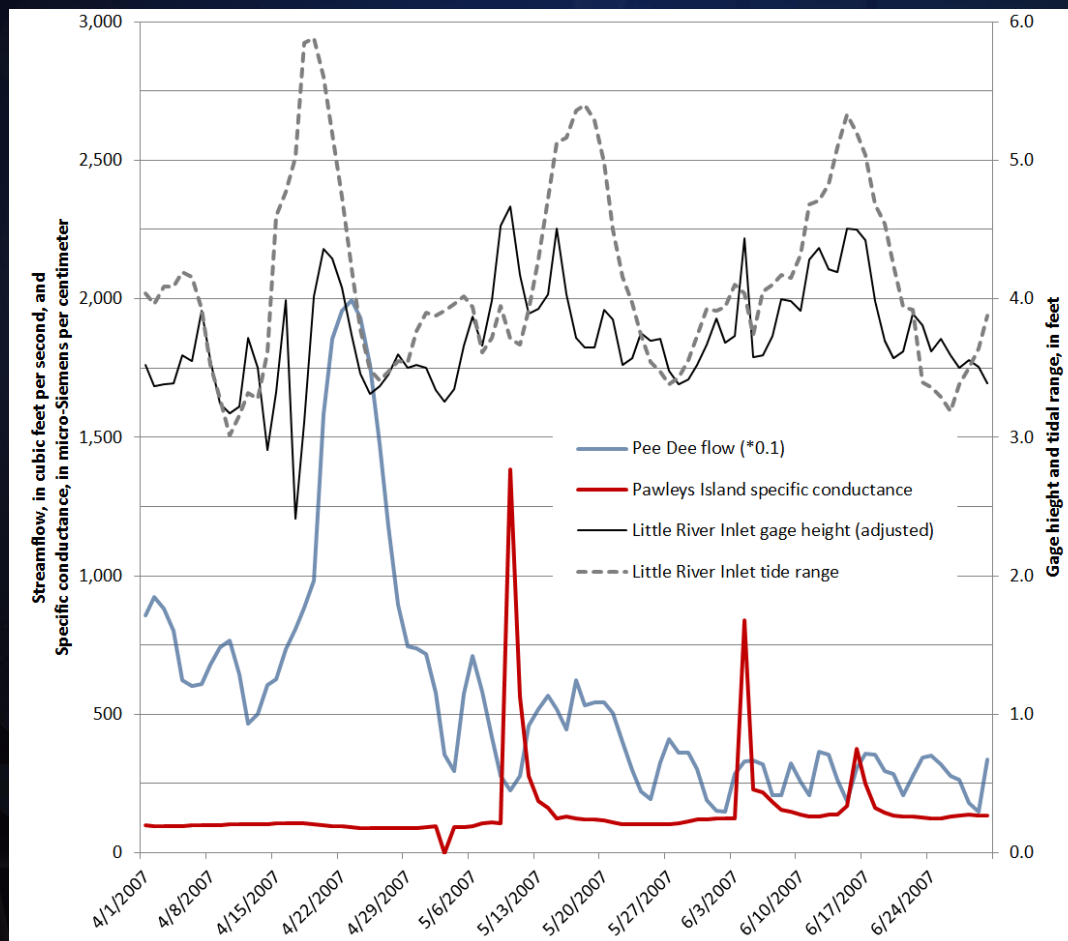
Tidal Range and Specific Conductance



Water Level and Specific Conductance



Converging Conditions: South End – Waccamaw River



Water Level and Tidal Range

